Report of the Defense Science Board Task Force on LHX Requirements

Office of the Under Secretary of Defense for Research and Engineering
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Report
of the
Defense Science Board
Task Force on
LHX Requirements

Office of the Under Secretary of Defense for Research and Engineering
Washington, D.C. 20301

August 1986

THE SECRETARY OF DEFENSE

WASHINGTON, THE DISTRICT OF COLUMBIA

September 22, 1986

MEMORANDUM FOR DEPUTY SECRETARY OF DEFENSE
SECRETARY OF THE ARMY
CHAIRMAN OF THE JCS
UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING
ASSISTANT SECRETARY OF DEFENSE FOR ACQUISITION AND LOGISTICS

SUBJECT: Implementation Plan for the Report of the DSB Task Force on LHX Requirements

At the request of the Under Secretary of Defense for Research and Engineering, a Defense Science Board (DSB) Task Force was established in December 1985 to test out the findings of the 1985 DSB Summer Study on Practical Functional Performance Requirements on a major program before a decision had to be made on whether the program should enter full-scale development. With the concurrence of the Under Secretary of the Army, the LHX program was chosen for this review. The purpose of this memorandum is to encourage the Army to give serious attention to the findings and recommendations of the DSB Task Force on the LHX, especially its summary finding that the review of the requirements process used to date on the LHX program reflects a need for a fundamental review of how the Army goes about satisfying its major material needs.

Since the findings of the LHX Task Force are applicable to other DOD programs, the Under Secretary of Defense for Research and Engineering and the Assistant Secretary of Defense for Acquisition and Logistics are asked to follow and assess this Army review, under the direction of the Defense Acquisition Executive. In addition, they are directed to assist the Army as much as possible to implement the following specific aspects of the LHX DSB Task Force's report:

1. To provide for competitive prototyping of at least the higher risk items in the system, carried to the point that critical program decisions can be made on the basis of achieved results rather than on the basis of mere projections.

2. To gain sufficient "up-front" funding for risk-reduction portions of the LHX program to allow for confident achievement of at least a core capability before the LHX enters full-scale development.

3. To develop a mechanism within the Army for regularly making requirements tradeoffs over time among all of its aviation system options, including the development and management of a process which will provide for realistic and useful options in a timely and affordable way.

William H. Taft, IV
Deputy Secretary of Defense

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301-3140

DEFENSE SCIENCE
BOARD

8 SEP 1986

MEMORANDUM FOR THE SECRETARY OF DEFENSE

THRU: UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

SUBJECT: LHX Task Force

I am pleased to submit the final report of the DSB Task Force on the Requirements for the Army's proposed new light helicopter (LHX) chaired by Mr. Robert R. Everett.

This Task Force was established at the request of USDRE to test the results of the DSB Summer Study on Practical Functional Performance Requirements on a major program still in the requirements phase. The selection of the LHX program for this purpose turns out to have been a wise choice. Although there can be little doubt about the Army's need to upgrade its light helicopter fleet, the Task Force determined from its review that the requirements/acquisition approach being taken to the LHX program is a classical example of that labelled "the DOD Problem Model" by the Summer Study, for reasons that go well beyond the LHX program or those in charge of its acquisition. As a result, I believe the Task Force's findings and recommendations are not only sound as regards to the LHX and its specific requirements, but also are broadly applicable to complex system programs across the whole of the DOD. I recommend that you read Mr. Everett's forwarding letter and the Executive Summary and sign the attached memorandum.

Charles A. Fowler

Charles A. Fowler
Chairman

Attachment
as stated

A-1

Robert R. Everett
President
617-271-2529

25 June 1986
A10-2420

Mr. Charles A. Fowler, Chairman
Defense Science Board
The Pentagon, Room 3D1034
Washington, DC 20301

Dear Mr. Chairman:

Enclosed with this letter is the final report of the Defense Science Board Task Force on LHX Requirements. This Task Force was established last December at the request of the Under Secretary of Defense (R&E) to attempt to apply the findings and recommendations of the 1985 DSB Summer Study panel on military requirements to an important new program before this program reached the full-scale development stage. The Task Force was also charged with reviewing the requirement for the LHX itself.

The Task Force has examined the current state of the requirements for the LHX and has concluded that the program is following almost exactly the DoD Problem Program process described in the 1985 DSB Summer Study Report. It sees a number of what are really simply Army goals becoming firm "requirements" of the program without adequate measurement of their consequences or of their tradeoff possibilities in the overall interest of the program. Therefore, while the Task Force has little doubt about the Army's very real need to upgrade its light helicopter fleet, it does have deep concerns about the future of this program as now being pursued.

The Task Force is convinced that there are serious difficulties with the LHX requirements process as it is currently under way, not because the people involved are not capable and hard working - they are - but because they are following a DoD acquisition system that is itself at fault and needs changing. We have not attempted therefore to suggest specific changes to the requirement but have instead concentrated on recommending a different approach to the problem which we believe will lead to an improved result.

We understand that many of the people from the Army and the contractors share our concerns and are sympathetic to our recommendations. The best way to proceed from here, in our opinion, is

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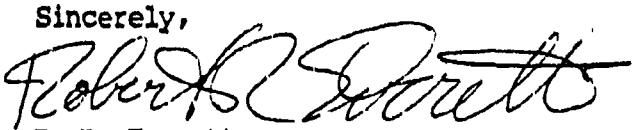
to encourage the Army to replan the program along the lines discussed and to review the results when available. The Task Force stands willing to assist in this process to the extent that OSD and the Army desire.

Let me take this opportunity to thank each of the members of the Task Force and its Working Group for the outstanding contributions they made to this report. The splendid assistance afforded the group by all levels of the Army in providing us with the facts, as well as the courtesy afforded us by the helicopter industry during our visits, should not go unmentioned as well. All in all, I believe that a sincere and dedicated effort was made by everyone involved to achieve the realistic perspective about the program which the report hopefully provides.

While the entire Task Force participated in the generation of the report, its Chairman, of course, bears principal responsibility for its content.

Sincerely,



R. R. Everett
LHX Task Force Chairman

CONTENTS

Introduction

Origin and Purpose of the Task Force - This DSB Task Force was formed at the request of the Under Secretary of Defense (R&E) in December 1985 to assess the Army's current effort to replace some of its aging fleet of lighter helicopters in several classes (scout, attack, and utility) with a single new helicopter: the LHX. The assessment was to include not only the process by which the Army's official requirement for the LHX was arrived at but also the specific requirement itself. The request of the Under Secretary represented an attempt to apply the findings and recommendations of the "1985 Defense Science Board Summer Study on Practical Functional Performance Requirements" (see its March 1986 Report) to an important program currently in acquisition but not yet in full-scale development.

Task Force Membership and Activities - Those who participated in the Task Force's efforts are listed in Appendix B. The activities of the group consisted of the items noted in Appendix C, plus interactions of the Chairman of the Task Force with the full DSB, the Chairman of the DSB's Management Panel, USDR&E, DUSDR&E(TWP), and various senior Army officials.

Executive Summary

The Task Force has examined the current state of the requirements for the LHX and has concluded that the program is following almost exactly the DoD Problem Program process described in the 1985 DSB Summer Study Report.* Therefore, while the Task Force has little doubt about the Army's very real need to upgrade its light helicopter fleet, it does have deep concerns about the future of this program as now being pursued.

Regarding the process, the Task Force finds that the budget competition is leading to overstated requirements, the CINCS have played little role in the process, R&D is incomplete, the contractors are under enormous pressure to swallow their concerns and accede to the government's desires, predictions of future funding are optimistic, planned production rates and unit cost estimates are unlikely to be met, source selection will be by paper competition, contracts will be inflexible fixed price, and the Program Manager is buried in the Army structure and has little flexibility.

Regarding the requirement itself, the Task Force's main concern is that the process is turning the Army's goals for the LHX into firm requirements that no one is willing to openly question. The Task Force does not believe that the totality of these goals can be met within the limitations of weight, cost, and existing technology, and does not see the mechanisms by which the needed tradeoffs and compromises can be made in order to reach a credible design.

* See Appendix D for this model.

On the other hand, the Task Force is convinced that the Army has a real need for a new light helicopter and that technology exists that can support the design of a satisfactory aircraft of much greater performance than the existing fleet.

Based on these conclusions, the Task Force makes the following recommendations:

1. The Army should commit itself to the development of a new light helicopter and turn its attention to determining what characteristics it should have to be useful, implementable, and affordable.

2. The Army should restate its goals as bands of performance within acceptable limits and priorities.

3. Competition should be carried to the point of testable prototypes on which program decisions can be confidently based.

4. An energetic and fully funded R&D program should be continued until the higher level technical uncertainties have been eliminated.

5. The Army should appoint a Surrogate Chief Executive Officer (SCEO) for the LHX and delegate to him the Army's authority and responsibility for the program.

6. The Army should assign someone with adequate time and resources (perhaps the SCEO for LHX) the task of managing the continuing process of modernizing the Army's rotary wing fleet.

CHAPTER I

Background of the LHX Program

The LHX is the name given to the Army's program to replace its aging and increasingly vulnerable fleet of light (3,000 to 10,000 pound) helicopters. The Army has some 7000 such helicopters which were acquired during the Vietnam War. They are approaching 20 years old; and many of them will be over 30 years of age before they will be replaced under the LHX program. In addition, the Army has in production a second generation of somewhat heavier attack (AH-64) and utility (UH-60) helicopters, as well as a major upgrade program (AHIP, designated OH-58D), for some of its light scout helicopters all of which are intended to perform the same basic functions as the old fleet. The acquisition program for the LHX is estimated to cost some $40 billion in current dollars, and is the largest Army program thus far contemplated. The Army originally planned to procure some 5000 of the new LHXs, in two versions--a scout-attack version (3000) and a utility version (2000)--over a 10-12 year period at a steady-state rate of 480/year. However, the Task Force now understands that the Army's plans are changing as regards quantities, schedules, and production rates, and are likely to change further.

CHAPTER II

Discussion

The basic requirement for the LHX is to replace the Army's aging and increasingly vulnerable fleet of light helicopters. In most private organizations, the concept of depreciation and obsolescence is well understood, cash flow is generated for replacement, and replacement is regularly planned for and carried out. This process is not followed in the Government, however, because it does not recognize depreciation in keeping its books. And so it demands some other justification for replacements. It is therefore necessary to make a case based on mission needs or on reduced cost of ownership, a process that characterizes the LHX and most other DoD replacement programs.

The Army has approached this justification problem from both directions, simultaneously claiming that the new helicopter will be less expensive to maintain (by 40% or more) and will have much higher survivability and effectiveness under battle conditions.

As a matter of fact, it is probably not possible to make a case for replacing the old fleet with new but identical equipment (although there is certainly room to increase the buy of the newer UH-60s, AH-64s, and perhaps even OH-58Ds). Helicopters do not appear to wear out or to reach a demonstrable end of life, if mechanical and structural replacement programs are implemented at appropriate points in the life cycle. With proper maintenance and overhaul, they will operate indefinitely. What has really happened is a steady

improvement in applicable technology: better engines, especially engine controls; better aerodynamics, especially blade design; composite materials; much improved flight controls and information displays; greatly improved navigation, sensors, and processing capability; much better simulators for design and training; and on-board maintenance techniques. The Army is therefore proposing to replace the old fleet with much better helicopters. The total resource of new technology can, however, be spent in many ways but not in all ways at once. The need, or the desire, or the "requirement" for improved performance and reduced ownership costs is essentially unlimited. The real requirements problem is to decide how to spend the limited supply of technology and money in order to get the best results.

The current requirement calls for reducing the cost of ownership of the fleet by roughly one-half by:

- the use of more reliable components and materials
- the use of more efficient maintenance methods including on-board diagnosis, black box replacement, and two-level maintenance
- one-man operation
- fewer aircraft of improved performance.

Predicting lower cost of ownership as a justification for equipment replacement has been common in DoD, but actual results have been disappointing. The reasons for this are only partly over-optimism and inadequate design. More

often they are due to much greater complexity, pressure to downgrade reliability and maintainability in order to maintain performance, and the discontinuity between the design of the equipment for performance and for production and the design of the maintenance system itself, carried out by others at a later time.

These problems will arise here. It is probably true that a new helicopter with the same performance as an old one could be designed for much lower O&M costs, but the proposed LHX, especially the Scout/Attack (SCAT) version, is much more complex than the ones it is to replace. The LHX will probably cost much less to maintain than if it were made out of old technology but since it will be several times as complex as the old one, the Army will be fortunate to break even.

A substantial fraction of the predicted savings results from the plan to eventually replace the existing light fleet with fewer aircraft. It is not clear, however, whether the Army plans to dispose of the entire old fleet or to keep some of them for various purposes, including National Guard/Army Reserve and war reserve applications. Furthermore, the appropriate number of helicopters in today's Army is not easy to estimate. The felt need or desire of the Army for helicopters is very large. The number they have is the result of those they have left over from the Vietnam War and those they have been able to buy since, less losses. The Task Force has been told that the planned production of AH-64s and UH-60s is much less than the Army really wants. The total amount of money for both procurement and O&M, spread over the Army force structure, will ultimately determine the diversity, quantity, quality, and age of Army equipment. It is beyond the Panel's competence to comment on the

"right" number of helicopters. It can be concluded, however, that an increase in the size of the present inventory will cost more and that estimates of the "savings" to be derived from the LHX program must be viewed in the context of the overall Army helicopter force structure.

One-man crews will reduce the cost of ownership per aircraft per crew. However, the Army clearly prefers to keep the number of crew members it now has and to use the resulting increase in the number of crews to increase aircraft utilization rates. Either way, the success of one-man crews depends on aircraft effectiveness under wartime conditions, a matter which is difficult to determine until war occurs, after which it may be too late to matter. Hedging the decision by designing the aircraft to hold a crew of two, if necessary, may or may not be desirable, but if done requires a certain flexibility of approach and a willingness to pay in dollars, weight, and performance for the hedge.

The survivability demands on the SCAT are very great. The half-life of a SCAT in high intensity battle conditions is likely to be short. What will probably happen is that the SCAT will actually be used in such a way as to have a reasonable chance of survival. The question then is what effectiveness it will have as actually used. Effectiveness is dependent on what is expected of it and, more importantly, on what weapons it will carry. Against tanks the SCAT needs better weapons. Against other aircraft, including helicopters, the SCAT needs better area surveillance and ground controls, as well as better weapons. The Task Force has the impression that the analyses tend to consider and evaluate the LHX as an autonomous vehicle. We do not see how this can lead to reliable results, especially in the new function of helicopter-to-helicopter

air combat in which there is little, if any, actual experience. In any case, there seems to be a good chance that the emphasis on reducing radar cross-section may be overdone, compromising many aspects of the SCAT design and raising costs substantially.

As far as the technology itself is concerned, much good work has been done but much remains to do. The Advanced Rotorcraft Technology Integration (ARTI) program has been successful as far as it has gone, but Congressional decisions to cut back on ARTI while complaining that the Army does not have all the answers it wants seems short-sighted, and should be the basis of continual Army reclama, with OSD support, rather than stretching out the program to try to accommodate such cuts. Much of the remaining uncertainty surrounds the questions of sensor displays and target recognition and the long-term desirability of having a one-man crew. The Task Force has two general views of this issue. The first is that development has not yet proceeded far enough to make firm decisions for the long term. The second is that since sensor and processing technology is progressing steadily, it does not seem necessary to proceed as if a commitment now will hold still for many years, perhaps decades. It may well be that by the time the vehicle itself is built and flying, available avionics will be very different. It might therefore be better to make a much more conservative initial decision about the avionics, provide for and expect more flexibility, and make block changes when the technology and the understanding of the new tactics it permits are available. A revitalized ARTI program would go a long way towards proceeding along this path.

The Army decision to go with a conventional helicopter might very well be sound if a firm "buy" decision had to be made at this time. But whether it will be sound for the next 20 to 30 years is much less clear. Tilt rotor, X-wing, and stealth, for example, are not as far advanced but may turn out to be more desirable, at least for some purposes. Hence, the effect of making a decision of such finality now is to let "the system" foreclose options that should be kept open.

The pressure from Congress and others to firmly pin down the cost of the LHX before allowing it to proceed is understandable but disturbing. It is not at all clear that the cost bogies established for the two versions of the LHX can be met if the requirements remain as stated, even if the proposed production rates and quantity goals are net. Production funding estimates appear optimistic even if political problems are ignored. Funding shortages plus cost overruns can substantially reduce production rates and further increase unit costs.

The rationale for combining the threat-driven SCAT requirement with the economy-driven utility configuration is questionable. There is considerable evidence that the utility design is being needlessly compromised by having to adapt major components from the "fighter"-driven design of the SCAT. Even the rotor parameters appear to be inefficient for an economical utility configuration. There are other designs available (some of which are commercial derivatives of Army-funded programs) which might be better suited to being UH-1 replacements.

The competitive situation is also disturbing. The public statement that production of existing models will be completed by about 1990 and that the only major buy in the 1990s will be LHX puts enormous pressure on the helicopter companies to agree to whatever is asked and hope for the best. A paper competition followed by a joint design, followed by co-production on the earlier lots, all on a fixed-price basis, may not be the best approach. Neither is taking advantage of the competitive situation in the helicopter industry to force company-financed facilitization, especially tooling and special-purpose test equipment, without indemnifying contractors for such financing.

Finally, the decision to give up prototype competition in order to save development money appears short-sighted. It is not necessary to carry prototyping to all up parallel full-scale development. Prototyping the higher risk parts of the design could have profound positive effects in disciplining the design specifications, maintaining competition, and discovering difficulties early in the process when they are relatively less expensive to fix. As with many other programs, it seems that the elimination of the prototype effort in the LHX program was decided on merely as a device to save near-term resources without adequate consideration of the effect of this decision on the eventual total cost of the program.

The goals that have been set for LHX, reasonable in themselves as ways to stretch the thinking of the development community, have been turned by the system into firm requirements. In the face of what appears to be a widespread belief that failure to meet the goals will result in program cancellation,

there appears to be no mechanism for bringing the specifications under control as long as the competition remains on paper. Prototyping, the construction, test, and comparison of real devices, can help to correct this problem and result in more believable specifications before final decisions are made.

The Cost and Operational Effectiveness Analysis (COEA) for the LHX program is not yet available and is not expected to be until Fall. But already there is evidence that the COEA will serve primarily as a justification for the LHX program rather than as an analysis of basic fleet modernization issues as originally intended. Moreover, a number of possible alternate solutions are either being ignored or are being considered in combinations which pre-ordain the outcome.

CHAPTER III

Findings on The Requirements Process

With these remarks as background, a comparison of the LHX requirements process with the recommendations of the DSB Summer Study follows:

1. The model being followed is very much like the one the 1985 DSB Summer Study called the "DoD Problem Program Model." This is not because the Army people involved are lacking in intelligence, interest, or energy--just the opposite--but because the "system" tends to force major programs into this mold.

2. The step in this model called "budget competition" (see Appendix D) is leading to overstated requirements. The ten pounds of reduced cost of ownership, increased survivability, speed, ferry range, single crew, etc., cannot be squeezed into the five pound bag of $5.3 million a copy and 8500 pounds of weight. The COEA appears to be largely a justification of previous conclusions reached by the Army. The over-stated requirements for the LHX can be achieved only if other Army inventory objectives are scaled downward.

3. The user CINCS have played little role, if any, in setting requirements, even in areas in which their input would be pertinent and helpful. Requirements have been iterated between the Army Materiel Command (AMC) and the Army Training and Doctrine Command (TRADOC). The CINCS have only recently been brought into the discussion, and the extent to which they can influence things at this stage

if they want to is unclear. More importantly, conditions are being set up so that the users will have no choice in the future but to accept the LHX, however it turns out, or make do with obsolete equipment.

4. The R&D, risk reduction, and test efforts necessary to form a sound foundation for Full Scale Engineering Development (FSED) are incomplete; and existing programs are inadequate to complete them, in spite of the fact that any extra time taken "up front" in the program to be sure of its validity will have a relatively small influence on the fleet replacement schedule as compared to budget considerations.

5. Pressures on the contractors to accede to the government's desires and to swallow their concerns are enormous, eliminating much of the incentive for providing innovation and realism in their proposals.

6. Predictions of future funding are optimistic and the amounts desired probably unobtainable. Planned production rates and costs are unlikely. Cost estimates are probably low. There are no management reserves allocated to the program.

7. Source selection will be by paper competition. Following source selection there will be no further competition until well into production. Proposed contracts will be fixed price and hence inflexible in their tradeoff potential.

8. The program manager is heavily committed to Army, OSD, and Congressional mandates and has little if any flexibility to change funds or performance.

9. The PM is buried in the Army structure. There is no one to whom he directly reports who is constantly viewing the LHX program in the context of the totality of evolving Army Aviation needs (including the related ground environment) and developing cross-program acquisition strategies and tradeoffs. The closest approximation in the LHX case is a combination of the Under Secretary and the Vice Chief of Staff of the Army, both of whom have many other responsibilities and are several layers removed from the program manager.

In sum, on the process aspect of the DSB Task Force's charter, it sees the Army headed for the classical DoD problem program in the LHX case. Specifically, it finds among other things which concern it, an inadequate and inflexible management structure for, and analytic approach to, the program; a decided conflict of decision criteria and too many people voting on or influencing these decisions; an acquisition strategy for the program that was evidently devised independently from an assessment of the risks of the program; and a lack of realism about likely Army procurement budgets for its aviation needs. The reasons for the Army getting itself into this position on the LHX program do not appear to be peculiar to this program or to the capability and efforts of the people involved in it. Rather, they seem to reflect a need for a fundamental review of how the Army goes about satisfying its major materiel needs in comparison to how it was done in some of the more successful DoD programs the 1985 DSB Summer Study Panel examined.

CHAPTER IV

Findings on the Requirement Itself

As to the requirement itself, the LHX program is considered to be important to the Army in the overall sense and hence is strongly supported by the Army leadership. However, the Task Force sees what it believes to be only Army goals for the program becoming rigid requirements far too early in the process --with likely negative consequences to the program. These and other Task Force concerns about the LHX requirement are as follows:

1. Single-Crew - The Single-Crew requirement for the SCAT version of the LHX is too firm a commitment at this point, because it is dependent on being successful in the high-risk Mission Equipment Package (MEP) portion of the program to a degree which is still debatable. On the one hand, some argue that the LHX is worth acquiring in the timeframe planned even without the full automatic target recognition (ATR) capability or all of the Very High Speed Integrated Circuits (VHSIC) and other data processing desired. On the other hand, some are dubious about eliminating the "other set of eyes" in the cockpit at this point, even if a one-man piloting capability is possible. But no one knows yet whether such a second crewman is worth his cost in dollars, weight, and space. And a decision-hedge at this point to design the aircraft to hold a crew of two in case they are needed may be tantamount to a decision to go to a two-man crew, because the penalties of the hedge can't be recovered. So while a commitment to the single-crew approach can be made at this point for discipline purposes, it can only be a preliminary one which holds while enough information is being gathered through continued ARTI work and through building/

testing mock-ups for both the one- and two-man versions to allow a firm commitment, one way or the other, to be made before FSED. The possible use of a single crewman has been a major driver of the LHX requirement to date, especially of its MFP aspects. If a single crewman is not selected, the whole LHX requirement should be thoroughly re-examined.

2. Commonality - Mandating commonality of the dynamic sub-systems of the SCAT and utility versions of the LHX in spite of their markedly different mission needs, and, hence, forcing them into a single "all-in-one-bucket" program for multiple and quite different Army users in the name of presumed logistical and production-cost savings, is a quite questionable requirement in the opinion of the Task Force, especially since it believes that the savings are probably exaggerated in both amount and importance.

In addition, the Task Force sees little reason why future scout aircraft need to be the same as expensive attack aircraft; i.e., it questions why they need to be combined into one version of the LHX called a "SCAT." The Army should, however, be able to utilize the technical and production capability of the attack model in acquiring a less expensive version for scouting purposes.

Finally, the Task Force believes that utility aircraft replacements may not need to be all (or even any) LHXs. Some might be less expensive UH-60s (at least when produced as add-ons to their current production), or, in some cases, minimally militarized versions or other derivatives of relatively inexpensive commercial helicopters. Both types of platforms should, of course, take advantage of LHX technological improvements over time.

3. Alternatives - The requirement is written in such a way as to effectively preclude the consideration of alternatives to the LHX that could run all the way from much smaller, fully-commercial helicopters acquired to run errands behind the Forward Line of Own Troops (FLOT), to technologically advanced possibilities that become desirable in the years ahead, such as tilt-rotor, Advancing Blade Concept (ABC), and X-wing aircraft. And, of course, there are all types of possibilities, and combinations thereof, in between that are being made possible by advancing avionics and mission electronics which could be taken advantage of through product improvement efforts and block upgrades on current as well as future aircraft.

4. Operating and Support (O&S) Cost Savings - The requirement is based too much on attaining significant amounts of unproven and unprovable (at this stage) savings in operational and support costs which may not only not materialize in so complex an aircraft as is being contemplated but which could even increase, based on DoD-wide experience over the years. This economic orientation to the requirement has not been adequately reconciled with its threat-driven focus, causing an ambivalence in the program's direction.

5. Survivability - The requirement calls for a design for survivability that is carried to a degree that the Task Force believes may not be warranted by either its cost in dollars and weight or its negative effect on weapons-carrying capacity. Particularly questionable here is a costly demand for the LHX vehicle to have a small radar cross-section in a combat environment in which radar-directed enemy systems are not the primary predators of U.S. helicopters. Conversely, little attention seems to have been paid to threats from acoustic and/or optically-directed systems.

6. Weight - Too specific statements of required weight are mandated, at levels that rule out too many alternatives and tradeoffs that should be examined at this early stage in the program. In addition, weight is used as a proxy for important program parameters such as cost which should be dealt with directly.

7. Speed - The speed requirement for the LHX has not been validated in relation to range; i.e., in terms of frontage or area coverage per unit of time, especially for military functions of organizational units above Army divisions. Nor, though apparently studied and simulated by the Army, is it really yet known whether the speed requirement is adequate against the threat from new, high performance Soviet helicopters, much less against the speed of tilt-rotor aircraft that might be introduced by the Soviets in the timeframe in which the LHXs would be entering the U.S. inventory.

8. Self-deployment - There is a requirement for a southern-route self-deployment range that drives too many design parameters, instead of being merely an Army goal. Indeed, the self-deployment feature of the LHX may be of questionable efficacy overall, in terms of cost and other desirable system characteristics against which it could be traded off. And its existence could be causing a lack of operational review of helicopter transportability by ships, in addition to airlift.

9. Competitive Prototyping - The requirement fails to exert the real pressure for competitive prototyping of at least selected aspects of the program that is needed at this stage of it. Such prototyping is considered by the Task Force to be the only approach through which the Army can both

provide an adequate incentive to contractors to try to optimize the tradeoff possibilities within the aircraft system and assure itself through actual data that its cost estimates for the program are realistic and that its performance goals are sufficiently valid to convert them, at the appropriate time, to specifications for subsequent stages of the program. Validation of the LHX's production and ownership costs should be a major focus of the prototyping effort.

10. Weapons - In spite of the focus of the LHX program's requirements being as much on threat as on economic considerations, it appears that they fail to provide adequately for the advanced type of weaponry the Task Force believes the LHX will need to defend itself in air-to-air combat or against enemy air defenses, much less to play a sufficient offensive role against, for example, modern armor to warrant the cost of its attack version. In addition, weapons and platform capability and their costs may not have been addressed together sufficiently, in a systems optimization effort. For example, low cost, expendable weapons, used in large numbers, might provide the same system effectiveness with a less complex and expensive platform.

CHAPTER V

Conclusions and Recommendations

As a result of these findings, the Task Force has come to the following conclusions and recommendations. It is aware that there is more than one way to satisfy these recommendations, especially in a particular context like the Army. They are offered in the spirit of hoping to evoke an Army reaction which will be useful not only on the immediate LHX program but also on other DoD programs which have the characteristics of the "DoD Problem Program Model."

Conclusion 1 - The Army does need to modernize its light helicopter fleet. The technology exists to design and build rotorcraft that are much improved over the present light fleet.

Recommendation 1 - The Army should firmly commit itself to acquiring a new fleet to replace its light helicopter one. However, the Task Force believes that a truly realistic approach to the design of such a fleet is unlikely to be achieved as long as there is widespread belief in the Army that the LHX program will not be approved unless a set of stringent goals can be met, or at least until everyone agrees they can be met whether they believe so or not. This situation should be turned around, so that the participants are motivated by the need to design an optimum capability rather than the need to sell a fixed approach. The question to be addressed is not whether a new aircraft or fleet should be developed, but what characteristics it should have to be useful, implementable, and affordable.

Conclusion 2 - Army goals for the LHX program have been turned by the system into firm but unmeetable requirements.

Recommendation 2 - The Army should restate its goals as desired bands of performance with minimum acceptable limits and priorities.

Conclusion 3 - The competition between the proposed teams of contractors will lack both discipline and credibility as long as it is planned to be merely a paper competition in which the winners will be selected on the basis of promises rather than results.

Recommendation 3 - The competition should include the construction of testable prototypes, carried to the point that critical program decisions can be based on them. Preferably, these prototypes should be of full systems, because of the complex nature of the LHX's mission equipment and avionics and their integration needs both among themselves and with the air vehicle, weapons, and new operating doctrine that they will permit. But at least they should cover selected, higher-risk items in various functional combinations. Contractors should be allowed to propose prototypes of an advanced concept nature if they want to, including tilt-rotor possibilities, rather than being required to offer only conventional helicopters. And the Army should continue to encourage the modification of present air vehicle platforms, in order to prove out in principle state-of-the-art concepts.

Conclusion 4 - The risk-reduction R&D effort necessary to allow for confident commitment to the full-scale development and Pre-planned product improvement (P^3I) phases of the program and to assure their schedule integrity is progressing

rapidly; but it is far from complete, especially as regards its target acquisition and data processing aspects. Such an R&D effort can also serve to keep down the costs of the prototyping activity.

Recommendation 4 - The Army should make every effort, with active OSD support, to assure the full and continuous funding of the ARTI program until the higher-level technical uncertainties have been eliminated from the program. It should also continue to fund and evaluate mockups of the one vs. two crewmen cockpits as a matter of special importance until a firm choice between the two can be made.

The Army should also separate out of the initial LHX program for separate P^3I treatment those technological efforts such as helmet-mounted displays, image processing, and the signal processing related to multi-sensor fusion whose art is advancing rapidly and which are applicable to more than the LHX program or even to all of Army aviation.

Conclusion 5 - There is no one in the Army below the Under Secretary and the Vice Chief of Staff with undivided authority over the LHX program. And both of these men have many other duties.

Recommendation 5 - The Army should appoint a surrogate Chief Executive Officer (SCEO) for the LHX program and delegate to him the Army's authority and responsibility for the program. The Army should also establish a streamlined communications channel between the SCEO and the LHX Program Manager (PM) to deal

with program tradeoffs, which the PM is encouraged to propose (especially those tradeoffs for which the Government alone is responsible, such as trading off performance for schedule or risk for cost), and other programmatic matters deemed to be within the decision purview of the SCEO.

Conclusion 6 - No mechanism exists in the Army for regularly making requirements tradeoffs over time among all of its aviation system options, including tradeoffs among and between the existing fleet and current production aircraft as well as future ones, as design and maintenance technology keep improving. Nor is there a formal, consistent mechanism for looking at these aviation systems as other than autonomous entities.

Recommendation 6 - The Army should assign someone with adequate time and resources the task of managing the continuing process of modernizing the Army's rotary wing fleet, or even, perhaps, all of its aviation inventory. One way of doing this would be to expand the duties of the SCEO for the LHX, an approach which the Task Force supports.

Specifically, the Task Force recommends that:

(a) the Army appoint an SCEO for all Army rotary wing aircraft and have reporting to him for appropriate matters the PMs for all such aircraft and related programs. The location of this SCEO in the Army organization is secondary to the authority assigned him by the Army and OSD.

(b) the Army plan for a realistic budget level for rotary wing development, procurement and update over a period of years, and assign to the SCEO the responsibility for planning and carrying out the activities necessary for replacing and improving the Army fleet.

(c) the SCEO organize a development process that will provide a continuous stream of new technology and devices that can be applied to vehicles in existence and in production as well as to those in development. He should also maintain suitable production lines and production capabilities, in order to allow continual choices for future buys and thus assure continued competition among suppliers. He should consider and, when desirable, buy commercial vehicles. He should plan for long-term developments, acquisitions, and logistic support, including reliability, maintainability, training, exercising, simulation, and evaluation. In sum, he should be responsible for the Army's entire rotary wing capability over the long haul.

The Task Force believes that all of the above recommendations are consistent with those of the President's Blue Ribbon (Packard) Commission on Defense Management as described in both its February 1986 Interim Report to the President and its April 1986 document "A Formula for Action."

APPENDIX A

WASHINGTON, DC 20301-3010

RESEARCH AND
ENGINEERING

16 DEC 1985

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Defense Science Board Task Force on LHX Requirements

Consistent with the approved charter for the Defense Science Board Standing Task Force on the Acquisition Process of the Department of Defense, you are requested to form a Subgroup to assess the required operational capability (ROC) of the Army's LHX Helicopter program. In light of the significant impact of the requirements on the acquisition process length and the cost, not only should this review examine the requirements process, as articulated by the 1985 Summer Study Requirements Task Force, but also the actual performance requirements.

Prior to the DSARC II, scheduled for the Summer of 1986, a subgroup report of findings and recommendations shall be presented to me. As a minimum the following items should be addressed:

1. Are the system performance requirements adequate and appropriate for the aircraft's missions and purposes? Are they flexible enough to allow tradeoffs between cost, schedule and performance requirements?

2 Are the CINCs involved in the development of the requirement. Has there been proper "iterative review" between the user, the R&D community, the developers and industry?

3. Has the cost/effectiveness of each requirement been addressed at the margin so as to avoid small potential increases in performance driving costs upward past the point of economic return. Have early tradeoffs been accomplished to assure performance requirements are not overstated or under costed?

4. Are technological risks identified and recognized in schedule length and availability of resources? Is there planning for growth to include preplanned product improvements?

5. Is the projected threat reasonable? Does it include a projection of future enemy aircraft and ground weapon system countermeasures?

6. Are reliability, availability and maintainability requirements adequately stated so as to drive the maintenance burden below those of current systems to be replaced, with appropriate reductions in life cycle cost of ownership?

7. Will maintaining full scale development schedule be a dominant program goal with contractual incentives for doing so?

This Task Force is being sponsored by the Deputy Under Secretary of Defense for Research and Engineering (Tactical Warfare Programs). Mr. Robert R. Everett has agreed to serve as Chairman of the Task Force The Executive Secretary will be Brigadier General Dave Funk, and Col. Donald W. Derrah, USA will be the DSB Secretariat Representative. It is not anticipated that your inquiry will need to go into any 'particular matters" within the meaning of Section 208 of Title 18, U.S. Code.

Donald A. Hicks

APPENDIX B

TASK FORCE PARTICIPANTS

MEMBERS

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D. Hardison

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M. Richey, Tech. Asst. to PM LHX

Colonel D. Derrah, DSB

Major M. Mehaffey, DCSOPS (Army)

APPENDIX C

TASK FORCE ACTIVITIES

Visits to All Four Helicopter Producer Plants:

Sikorsky	- 1/17/86
Bell	- 1/21/86
McDonnell-Douglas	- 1/22/86
Boeing-Vertol	- 3/10/86

Panel Meetings, with Related Army Briefings:

3-4 February (with Under Secretary of the Army, Ambrose)

27-28 February (with Vice Chief of Staff, General Thurman)

31 March and 1 April (with TRADOC and AMC Reps)

28-29 April (with Commanding Generals of AVSCOM and AAVNC)

22 May to Review Draft Report

APPENDIX D

SYSTEM MODELS

A review of the case studies indicates that there are two general models of the acquisition process, one of which characterizes the commercial process (at least for the successful programs studied) and one which characterizes the DoD process (at least for the unsuccessful programs studied). We do not want to imply that all commercial programs are alike or are successful, nor do we imply that all DoD programs are alike or unsuccessful. We do see certain fundamental differences and believe that the closer a program is to the "Commercial Model" the more likely it is to succeed and the closer it is to the "Government Model" the more likely it is to fail.

The Commercial Model is shown in Figure 1. There are three major players, a Program Manager or PM who does the work, a Chief Executive Officer or CEO who makes the major decisions and a user or group of users who decide the ultimate success or failure of the program. There are many minor players, of course, including inside staffs, government regulators, consumerists, etc., but one of the major advantages of the Commercial Model is that the minor players play a minor role.

The first step in the model is for the PM to put together a realistic proposal for the CEO to consider. The PM knows what resources and what technologies are available, backed where necessary with company R&D funds. The

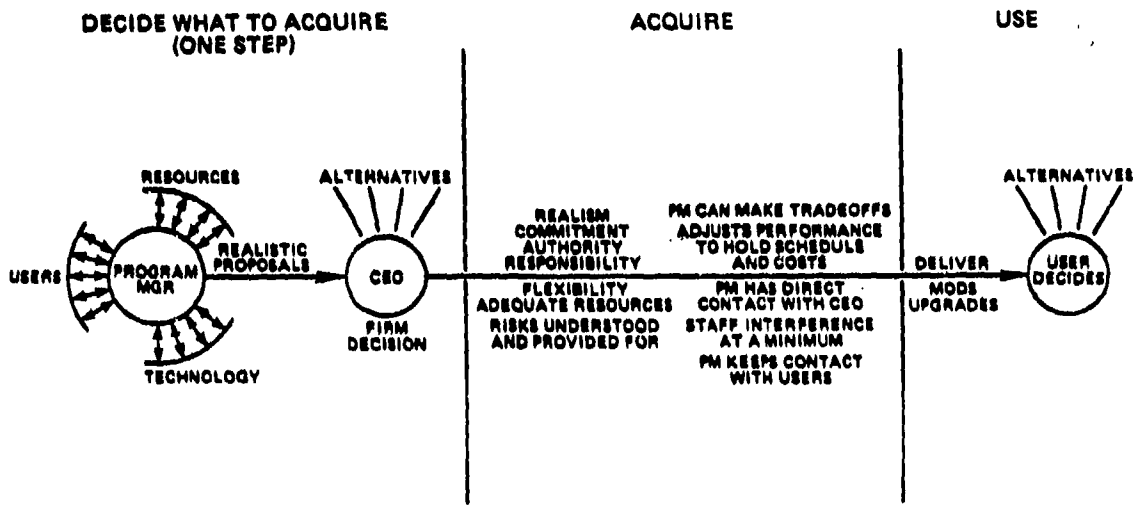

Figure 1. COMMERCIAL MODEL

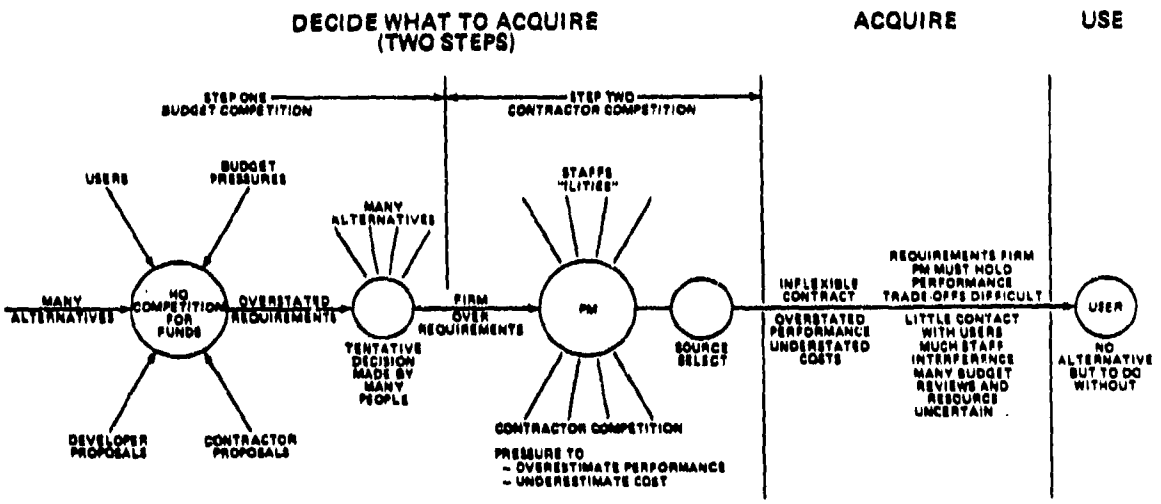

Figure 2. DOD MODEL

PM pays a lot of attention to the users' wants and needs because he knows that they will eventually decide whether or not to buy. How he involves the users is up to him, but involve them he must if he is to succeed. The PM is motivated to be realistic about performance, cost and schedule, both because he will have to carry out the program if it is approved and because his job is dependent on the merits of his proposal and not simply on whether it is accepted.

The CEO has clear cut decision authority. He may have to deal with Boards of Directors, bankers, etc., but they are just elements of his problem. He must decide whether or not to proceed and his decision must stick. The CEO has alternatives to proceeding; he can send the proposal back for redo or he can cancel the program and put his resources somewhere else. His future depends on whether programs he approves are ultimately successful, not on whether or not he goes ahead with them.

The CEO and the PM must have a close working relationship, direct access to each other, and mutual trust. The CEO can have, and probably will have, advice from many others which he can take into account or not, as he wishes.

A decision to proceed is a firm decision based on a realistic commitment on the part of both the CEO and PM. This commitment involves a clear agreement on authority, responsibility and flexibility, an understanding of the risks involved and an agreement on the resources to be made available, including adequate resources to cope with contingencies. In turn the PM commits himself to performance, cost and schedule. Note that the process of reaching this decision is really a single step although it may be lengthy and expensive and go through many iterations.

The acquisition of a complex system involves many uncertainties. The PM copes with these in two ways. First, he has some flexibility in performance goals and second, he has some resources to reduce these uncertainties and to cover contingencies. In general, he holds schedules and relaxes performance if he must, both because timing is important in a competitive market and because holding schedule tends to hold cost. If he gets in trouble, he goes back to the CEO who can grant additional resources of time or money or can adjust performance goals. If things get too far out of line and the CEO decides the program no longer makes sense, he can cancel.

Once again the CEO and the PM must have a close working relationship. The CEO must be kept informed and the PM must be able to get help rapidly and reliably if he needs it. The principle is one of a joint activity toward a common goal. A program failure is a failure of both CEO and PM.

The staffs and inspectors, test groups and "-ilities" groups exist, but are insulated from the PM by the CEO. The staffs can talk to the PM and comment and advise but cannot direct the PM without going through the CEO. Only the PM and the CEO can make decisions; they have the responsibility and therefore the authority.

When the development is complete, the product is produced and delivered to the users. It is fundamental to the model that the users have alternatives to buying the product. They can buy from a different source or spend their money in some entirely different way. This user choice, or competitive market, is what really makes the system work. The CEO/PM combination must seriously consider the users wants and needs, must make realistic plans and commitments,

must hold to costs and schedules, must fend off the nit-pickers and keep the program under control or they cannot hope to sell it in the end.

The DoD Model is shown in Figure 2. There are many more people involved, they have far less continuity of position, and they have different and sometimes conflicting degrees of authority, responsibility, and interests.

The DoD process for reaching agreement on what is to be acquired really involves two steps. It begins with a competition for funds, carried out in a highly political environment involving the Services, OSD, OMB, and the Congress. There are many alternative uses for the funds proposed by both government and industry for similar and different products. There are great pressures to overpromise in order to survive the competition. Since the decisions are made by political processes among a large and diverse group of people, there is little pressure to discipline the process and to enforce realism. Clear-cut designs to meet the requirements are not allowed because they would interfere with the next step--competitive source selection. The result is a firm over-stated requirement which too frequently can neither be met nor changed.

Note that in this second model there is no equivalent to the commercial CEO. Although the DoD is nominally a hierarchical authoritative organization, it is very difficult in a democracy for anyone to make a controversial decision stick. The successful commercial programs we looked at were of great importance to the companies involved and therefore to the CEO. There is hardly any single program in DoD of equivalent importance to Service Secretaries, let alone to the Secretary of Defense. DoD has too many important programs for such officials to keep track of them in detail.

The second step is to hold a competition among potential suppliers. The requirement is firm and difficult or impossible to meet, and the contractors are under great pressure to overestimate what they can do and to underestimate what it will cost. Although the requirement is firm, the decision to proceed with the program is not. The losing players in the first step are still around and hoping for another chance. It is difficult for the PM to be realistic and he has no CEO to help him.

The result is an inflexible contract with inadequate resources, overstated performance goals, and concealed risks. The PM has little ability to cope with the inevitable troubles. He tends to keep these to himself because reporting them gets him much attention and little help. When the trouble gets so bad that it can no longer be kept quiet, it is extremely expensive to fix.

Staffs and "-ilities" groups are numerous and continually harass the PM who has little protection from them. Many of them were established in the hope of preventing past troubles and have authority to interfere but no responsibility for getting out a product. Although the PM's commitments up are firm, commitments down are not, and changes in funding are common. The PM is usually forced to hold performance constant, so trouble results in slipping schedules and rising costs.

Eventually, after much difficulty, the product reaches the user. The situation is now reversed; the PM has the advantage because the user has no alternative but to accept it or do without. The more fuss the user makes about the product, the longer it will take to fix it, the more it will cost, and the fewer he will get. The user's ability to influence the design is limited

throughout the process. It is probably greatest in the first stage, depending on how much political influence the user has and is willing to expend. His influence gets less as time goes on.

We would hardly claim that all DoD programs go according to this model. We all know of successful high priority programs that have avoided many of these difficulties. Yet it is obvious that successful programs tend to be like the Commercial Model which is driven by market forces, rather than like the Government Model which is not. To improve the DoD process, we should move it toward the Commercial Model insofar as that is possible.

Unfortunately, normal human reactions are in the opposite direction. Bad prior decisions lead to adding more people to the decision process, which is exactly the wrong thing to do. As a general rule, the more people involved, the worse the decision. Any person or group added to the current process, no matter how able and motivated, will make things worse. We need fewer people in the decision process, not more.

Inefficiencies and high costs lead to demands for more competition, but competitions in promises do not help. The two-step process creates a separation between the funding decision and the source selection or design decision makes it extremely difficult to get a realistic match between requirements, costs, and schedules. In many cases, less formal, but no less real competitions earlier in the process would help.

Missed goals lead to demands for firmer contracts within DoD, and between DoD and industry, but there is now inadequate flexibility to cope with troubles, and still less flexibility will only make matters worse.

Unsatisfactory performance in the field leads to demands for more operational test and evaluation, but OT&E will not help the user if he has no alternatives. The lack of user alternatives leads to lack of user influence, which leads to lack of realism throughout the process.

What should we do? We could start by not making things worse. We could review the current process and make it more like the Commercial Model where we can. In particular, we could provide for clear-cut personal accountability for results and less obeisance to the letter of procedures. In addition, we could reduce the number of people in the decision chain by establishing surrogate CEOs with the authority and responsibility to play the role of their commercial counterparts. We could give the PM more flexibility to adjust performance to hold to schedules and costs. We could find ways to involve users more throughout the acquisition process and to give them alternatives and the chance to say that they will not accept a product. None of these are easy; but they would at least be in the right direction.

Surrogate CEOs

As discussed above, one of the striking differences between the Commercial and the Government Models is the role of the CEO. There is no equivalent to the CEO in the DoD. There are many important programs in DoD and many important people. No one person has the authority to make firm decisions. Decisions are

made by a large, diffuse group that acts something like an extended committee and that lacks clear-cut responsibility and accountability. The DoD itself exists in a political environment that further smears out the decision-making process. As a result, decision-making is lengthy and uncertain. The players change and the decisions tend to change with them. The Program Manager is separated from the top level of the DoD by many intermediate layers, all of whom must be dealt with, none of whom can say yes, but most of whom can say no. Decisions are late, inconsistent, and untrustworthy.

The Commercial Model demonstrates that both an accountable PM and a CEO who can make firm decisions are needed. Increasing the authority of the PM alone will not solve the problem. Attempts to streamline the process and to connect the PM more directly to the top of the DoD have not been successful except in extraordinary cases. There are too many programs for the top level to understand in detail. They must rely on their staffs and authority rediffuses in the bureaucracy.

The Task Force suggests establishing what we have called Surrogate CEOs. These are individuals who have been delegated authority and responsibility to act as decision-makers for one or a few programs. The PMs should report directly to them on program matters. The Surrogate CEO should make decisions on matters for which he has authority, insulate his PMs from the staffs, and deal with upper echelons as necessary. His success will depend on how much authority he really has, to adjust performance and schedule, provide additional resources if needed, make or approve tradeoffs. If he is responsible for only a single program or for a group of separate programs, his ability to provide

resources will be limited. If he has responsibility for a group of related programs he could trade-off among them and could be more effective. Too often today, what we call systems do not provide any military capability in themselves. They are only components of larger systems which are often left undefined. A Surrogate CEO with a group of related programs might be able to help develop real military capability in his assigned area.

It is not of first importance where the Surrogate CEO sits in the hierarchy. The important things are that the Surrogate CEO should have appropriate background and the confidence of the community so that he can, in fact, be delegated adequate authority, and that he have few enough programs under him so that he can understand and keep adequate track of each in addition to his other responsibilities (in general, Surrogate CEO is not his full time job).

A supervisor or commander in the current DoD structure is not equivalent to a Surrogate CEO because he does not have the necessary delegated authority. In general, the commander of a development organization is a kind of super PM whose superior rank and experience can be used to assist the PMs under his direction, and who can assign and organize the people resources available to him. He does not have any more authority over performance, cost, and schedule of his programs than his PMs do. He cannot transfer funds among programs and he has almost no discretionary money under his control. His control of staff and monitoring groups is minimal. He is overcommitted and has almost no flexibility.

If, in spite of these drawbacks, commanders of development agencies were asked to act as Surrogate CEOs, it probably would avoid confusion about who the PM reports to. However, a commander of a large organization cannot act as Surrogate CEO for more than a few programs, and he would have to recognize that he would have subordinates who are Surrogate CEOs for other programs over which he has no program authority. This points out the essence of the Surrogate CEO idea, which is not that PM reports to him, but that he has been delegated the authority to make decisions about the program. The law of conservation of authority says that this delegated authority must come from somewhere and it must come, in fact, from the Surrogate CEO's superiors and from the staffs and regulatory bodies in the government. These people, in the manner of all human beings, will resist giving up authority even when they understand that their previous activities have been harmful rather than helpful. Delegation must begin at the top. If the most senior people will really delegate their authority and insist that it be further delegated to Surrogate CEOs, there is a chance the idea will succeed. There will still be plenty of other things for the senior people to do.